a flight tube that receives said secondary beam;

an acceleration chamber that directs said secondary beam into said flight tube;

an electron multiplier that receives said secondary beam and produces an electron emission in response to each particle in said secondary beam;

a first anode that has a first electrical potential and that receives a first portion of each said electron emission and produces a first signal in response;

a second anode that has a second electrical potential different from said first electrical potential and that receives a second portion of each said electron emission and produces a second signal in response wherein said second portion is different from said first portion due to said different second electrical potential;

a first preamplifier that receives said first signal and produces a first amplified signal in response;

a second preamplifier that receives said second signal and produces a second amplified signal in response;

a first constant fraction discriminator that receives said first amplified signal and produces a first pulse in response;

a second constant fraction discriminator that receives said second amplified signal and produces a second pulse in response;

a first time-to-digital converter that receives said first pulse and produces a first digital signal representative of said first pulse's time of arrival;

a second time-to-digital converter that receives said second pulse and produces a second digital signal representative of said second pulse's time of arrival; and,

a computer that receives said first digital signal and said second digital signal and produces an ion spectrum.

2. A time-of-flight mass spectrometer comprising:

an ion source that produces a primary beam of ionized particles;

transmission optics that focus said primary beam;

an extraction chamber that produces a secondary beam of ionized particles from said primary beam;

a flight tube that receives said secondary beam;

an acceleration chamber that directs said secondary beam into said flight tube;

an electron multiplier that receives said secondary beam and produces an electron emission in response to each particle in said secondary beam;

a first anode that receives a first portion of each said electron emission and produces a first signal in response;

a second anode that receives a second portion of each said electron emission and produces a second signal in response wherein said second portion is different from said first portion due to the application of a magnetic field;

a first preamplifier that receives said first signal and produces a first amplified signal in response;

a second preamplifier that receives said second signal and produces a second amplified signal in response;

a first constant fraction discriminator that receives said first amplified signal and produces a first pulse in response;

a second constant fraction discriminator that receives said second amplified signal and produces a second pulse in response;

a first time-to-digital converter that receives said first pulse and produces a first digital signal representative of said first pulse's time of arrival;

a second time-to-digital converter that receives said second pulse and produces a second digital signal representative of said second pulse's time of arrival; and,

a computer that receives said first digital signal and said second digital signal and produces an ion spectrum.

3. A time-of-flight mass spectrometer comprising:

an ion source that produces a primary beam of ionized particles;

transmission optics that focus said primary beam;

an extraction chamber that produces a secondary beam of ionized particles from said primary beam;

a flight tube that receives said secondary beam;

an acceleration chamber that directs said secondary beam into said flight tube;

an electron multiplier that receives said secondary beam and produces an electron emission in response to each particle in said secondary beam;

a first anode that receives a first portion of each said electron emission and produces a first signal in response;

a second anode that receives a second portion of each said electron emission and produces a second signal in response wherein said second portion is different from said first portion due to said flight tube's physical geometry;

a first preamplifier that receives said first signal and produces a first amplified signal in response;

a second preamplifier that receives said second signal and produces a second amplified signal in response;

a first constant fraction discriminator that receives said first amplified signal and produces a first pulse in response;

a second constant fraction discriminator that receives said second amplified signal and produces a second pulse in response;

a first time-to-digital converter that receives said first pulse and produces a first digital signal representative of said first pulse's time of arrival;

a second time-to-digital converter that receives said second pulse and produces a second digital signal representative of said second pulse's time of arrival; and,

a computer that receives said first digital signal and said second digital signal and produces an ion spectrum.

4. A time-of-flight mass spectrometer comprising:

an ion source that produces a primary beam of ionized particles;

transmission optics that focus said primary beam;

an extraction chamber that produces a secondary beam of ionized particles from said primary beam;

a flight tube that receives said secondary beam;

an acceleration chamber that directs said secondary beam into said flight tube;

an electron multiplier that receives said secondary beam and produces an electron emission in response to each particle in said secondary beam;

a first anode that has a first electrical potential and that receives a first portion of each said electron emission and produces a first signal in response;

a second anode that has a second electrical potential different from said first electrical potential and that receives a second portion of each said electron emission and produces a second signal in response wherein said second portion is different from said first portion due to the

application of a magnetic field and said different second electrical potential;

a first preamplifier that receives said first signal and produces a first amplified signal in response;

a second preamplifier that receives said second signal and produces a second amplified signal in response;

a first constant fraction discriminator that receives said first amplified signal and produces a first pulse in response;

a second constant fraction discriminator that receives said second amplified signal and produces a second pulse in response;

a first time-to-digital converter that receives said first pulse and produces a first digital signal representative of said first pulse's time of arrival;

a second time-to-digital converter that receives said second pulse and produces a second digital signal representative of said second pulse's time of arrival; and,

a computer that receives said first digital signal and said second digital signal and produces an ion spectrum.

5. A time-of-flight mass spectrometer comprising:

an ion source that produces a primary beam of ionized particles;

transmission optics that focus said primary beam;

an extraction chamber that produces a secondary beam of ionized particles from said primary beam;

a flight tube that receives said secondary beam;

an acceleration chamber that directs said secondary beam into said flight tube;

an electron multiplier that receives said secondary beam and produces an electron emission in response to each particle in said secondary beam;

a first anode that has a first electrical potential and that receives a first portion of each said electron emission and produces a first signal in response;

a second anode that has a second electrical potential different from said first electrical potential and that receives a second portion of each said electron emission and produces a second signal in response wherein said second portion is different from said first portion due to said flight tube's physical geometry and said different second electrical potential;

a first preamplifier that receives said first signal and produces a first amplified signal in response;

a second preamplifier that receives said second signal and produces a second amplified signal in response;

a first constant fraction discriminator that receives said first amplified signal and produces a first pulse in response;

a second constant fraction discriminator that receives said second amplified signal and produces a second pulse in response;

a first time-to-digital converter that receives said first pulse and produces a first digital signal representative of said first pulse's time of arrival;

a second time-to-digital converter that receives said second pulse and produces a second digital signal representative of said second pulse's time of arrival; and,

a computer that receives said first digital signal and said second digital signal and produces an ion spectrum.

6. A time-of-flight mass spectrometer comprising:

an ion source that produces a primary beam of ionized particles;

transmission optics that focus said primary beam;

an extraction chamber that produces a secondary beam of ionized particles from said primary beam;

a flight tube that receives said secondary beam;

an acceleration chamber that directs said secondary beam into said flight tube;

an electron multiplier that receives said secondary beam and produces an electron emission in response to each particle in said secondary beam;

a first anode that receives a first portion of each said electron emission and produces a first signal in response;

a second anode that receives a second portion of each said electron emission and produces a second signal in response wherein said second portion is different from said first portion due to the application of a magnetic field and said flight tube's physical geometry;

a first preamplifier that receives said first signal and produces a first amplified signal in response;

a second preamplifier that receives said second signal and produces a second amplified signal in response;

a first constant fraction discriminator that receives said first amplified signal and produces a first pulse in response;

a second constant fraction discriminator that receives said second amplified signal and produces a second pulse in response;

a first time-to-digital converter that receives said first pulse and produces a first digital signal representative of said first pulse's time of arrival;

a second time-to-digital converter that receives said second pulse and produces a second digital signal representative of said second pulse's time of arrival; and,

a computer that receives said first digital signal and said second digital signal and produces an ion spectrum.

7. A time-of-flight mass spectrometer comprising:

an ion source that produces a primary beam of ionized particles;

transmission optics that focus said primary beam;

an extraction chamber that produces a secondary beam of ionized particles from said primary beam;

a flight tube that receives said secondary beam;

an acceleration chamber that directs said secondary beam into said flight tube;

an electron multiplier that receives said secondary beam and produces an electron emission in response to each particle in said secondary beam;

a first anode that has a first electrical potential and that receives a first portion of each said electron emission and produces a first signal in response;

a second anode that has a second electrical potential different from said first electrical potential and that receives a second portion of each said electron emission and produces a second signal in response wherein said second portion is different from said first portion due to the application of a magnetic field, said flight tube's physical geometry, and said different second electrical potential;

a first preamplifier that receives said first signal and produces a first amplified signal in response;

a second preamplifier that receives said second signal and produces a second amplified signal in response;